The Effects of Volcanic Ash on Water Supplies

General Summary of: ***USGS Volcanic Ash Website -- http://volcanoes.usgs.gov/ash/index.html***

Outline of Impacts

1. Short-term physical and chemical changes in water quality

2. High demand for water during cleanup operations

3. Increased wear on water-delivery and treatment systems

Historical eruptions generally have caused a small number of water-quality problems; hazardous chemical changes have been reported in only a few cases. A primary risk posed to water systems during past eruptions in Alaska has been the potential for water shortages.

Water Quality

The most common ash-contamination problems result from a change in turbidity and acidity, but these usually last a few hours to a few days unless the ash fall occurs for prolonged periods of time. Hazardous changes in water chemistry are rare. Close to a volcano, however, water-soluble components that cling to particles of glass and crystals of the ash may lead to chemical changes in water supplies that render the water temporarily unsuitable for drinking.

Relative vulnerability to volcanic ash contamination of water supplies (Johnston, 1997).

Threat Type	River/stream	Reservoir	Groundwater	Roof-fed/water troughs
chemical	low to medium	low to medium	low	high
pH	low to medium[1]	low to high[1]	low	high
turbidity	high	medium to high	low	high

[1] Depends on the ash thickness and water volume ratio

Turbidity

Ash fall over areas supplied by open-water systems can increase turbidity significantly for short periods of time (days to a week) of time. The 1953 eruption of Mount Spurr resulted in an ash fall of 3-6 mm in Anchorage, causing the turbidity of the public water supply to rise from 5 ppm to 290 ppm; it took six days to return to normal (Blong, 1984).

When ash fall causes water turbidity to increase, depending on the situation, public officials may advise consumers to boil water before drinking as the effectiveness of any disinfection or flocculation process has been compromised. However, boiling water is not ideal as it may concentrate the inorganic and organic chemicals found in ash.

Volcanic ash suspended in water can clog and damage filters at intake structures and treatment plants and increase the wear on pumps used in water-delivery systems.

pH
Fresh volcanic ash typically lowers the pH of water. The 1953 eruption of Mount Spurr caused the pH of the public water supply to fall to 4.5; within a few hours, the pH returned to 7.9.

Chemistry
Potentially harmful substances in some volcanic ash are the water-soluble materials called leachates, mostly acids and salts, which cling to the particles of glass and crystals. Observations from historical eruptions show that concentrations of hazardous leachates in ash decrease with increasing distance from an erupting volcano, with few examples of serious chemical contamination of potable water supplies.
Fluorine/Fluoride: Excess fluorine/fluoride is recognized as the most hazardous leachate in water supplies, but few historical eruptions are known to have resulted in fluorine poisoning in humans. The main concern of fluorine poisoning is for livestock, which graze on ash-contaminated grass and feed.

Water Demand

It may be necessary to control water demand in order to avoid water shortages for critical uses (especially for fire suppression, drinking water, and sanitation). A discrepancy between water demand and supply may be created by water pressure and supply problems, as well as an increased demand for ash cleanup.

The high demand for water that typically occurs after an ash fall can lead to temporary water shortages, especially if there are problems with water quality and supply. It may be necessary to employ water-use restrictions or rationing after ash fall as people try to wash off cars, homes and buildings, and streets. For example, after the 1980 eruption of Mount St. Helens, some communities imposed an odds-even rationing system based on house numbers and dates and restricted water supply to the largest customers. One community imposed rationing only during the peak demand hours to ensure that line pressure was kept up in the event of a fire or some other high requirement situation. If uncontaminated ground water sources had not been available to most communities downwind of Mount St. Helens, the demand would have exceeded supply to a much greater extent (Blong, 1984). It may be wise to employ such restrictions early, even before any demand/supply discrepancy becomes apparent.

Equipment Damage

Volcanic ash suspended in water can clog and damage filters at intake structures and treatment plants, and ash can increase wear on pumps and other equipment used in water-delivery systems. Because volcanic ash consists of tiny pieces rock and volcanic glass, ash can infiltrate nearly every opening and abrade or scratch most surfaces, especially between moving parts of equipment. Ash particles easily clog air-filtration systems, which can lead to overheating and engine failure. Damage to water-supply pipes from ash fall has generally been minor.

Mitigation Measures

Source Supplies

Water supply intakes should be closed before turbidity and acidity levels become excessive; regular monitoring will determine when such levels are reached and indicate when the intakes can be opened again. High turbidity levels are usually manageable if water-treatment filters are cleaned or replaced frequently. Filters can become blocked, however, if turbidity levels become excessive. Again, when turbidity is high, precautionary warnings to "boil water" might be issued to residents because the suspended ash may have decreased the effectiveness of any disinfection or flocculation process. <u>However, boiling water is not ideal as it may concentrate the inorganic and organic chemicals found in ash.</u>

As the fine ash can remain in suspension for long periods (days to weeks) a coagulation-flocculating agent may need to be added. Alum is found to be the best agent (Hindin, 1981).

To reduce the physical damage to water supply systems, equipment and pumps should be covered when there is an impending ash fall, and the ash should be removed before normal operations resume.

Water Tank & Farm Water Troughs

In addition to potential turbidity and acidity problems, bodies of water close to an erupting volcano with low volume-to-catchment-area ratios may be subject to chemical contamination by leachates, notably fluorine. When ash fall occurs, households with roof water supply should immediately disconnect down pipes connected to a water-supply tank. If ash collects on a roof and down pipes were not disconnected, it is recommended that the tank water be tested before it is used for potable water. If testing is not available it would be advisable to drain and flush the tank and refill with uncontaminated water.

Farm water troughs are highly vulnerable to contamination and would most probably need to be emptied and refilled after ash falls.

A covered water tank will be safe from direct ash fall contamination, and it may provide valuable water supply during periods ash fall if water use is carefully conserved. Water inflow should be closed before ash lands on the source (the house roof in this case), and the top must be regularly swept/shoveled free of ash to avoid collapse. The inflow should not be opened again until the chemical effect of the ash on water supply is determined safe, or the source is cleared of ash.

Mount Spurr Case Study

The 1959 eruption of Mount Spur deposited 3-6 mm of ash on Anchorage, causing short term pH and turbidity problems with the city's water supply (Wilcox, 1959). The pH level fell to 4.5 before returning to normal after a few hours. Turbidity rose from 5 ppm to 290 ppm and lasted six days before returning to normal.

The August 1992 eruption deposited about 3 mm of fine sand-sized volcanic ash on the city (Johnston, 1997b). The clean-up of ash resulted in excessive demands for water and caused major problems for the Anchorage Water and Wastewater Utility (AWWU) water production and distribution systems (AWWU pers comm.). The AWWU received a warning of the impending ash fall on the afternoon of 18 August. No action was taken that evening.

As one staff member described "we did not equate ash fall to high water demand... we were not prepared for what happened... had we known we would have moved to fill reservoirs sooner." By 10 am on 19 August (the day following the ash fall) a peak four hour demand of 230 million liters per day was recorded, about a 70 percent increase in normal demand (see graph below). Despite adequate production capacity, physical restrictions within the distribution system prevented the utility from moving sufficient water volumes to meet demand in parts of Anchorage.

The high water demand caused widespread water-pressure and -supply problems throughout 19 August, with levels in several storage reservoirs dropping to dangerously low levels. Some reservoirs were isolated from the immediate distribution system to ensure adequate volumes for fire suppression if required. At least one reservoir was completely emptied. Had fires occurred in parts of the city no water would have been available.

Opening of the Anchorage International Airport was delayed for several hours due to shortages of water to clean the runways. Stranded passengers were unable to use the toilets due to the lack of water.

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